

# **ACADEMIA-INDUSTRY R&D COLLABORATION**

A Biographical Perspective on the Philosophy and Experience of  
Professor Arun S. Mujumdar

Prepared for international colleagues, mentees and the wider engineering  
community

A concise biographical essay based on Professor Mujumdar's published editorials, presentations and reflections on academic-industrial research collaboration.

## Introduction

For more than five decades, Professor Arun S. Mujumdar has worked at the intersection of fundamental engineering science, applied research, education and industrial technology. His career in heat and mass transfer, drying science and technology, and transport processes has given him an unusually long perspective on how academic research can interact with industry.

A recurring theme in his writings and professional presentations is the importance of constructive academia-industry cooperation in research and development (R&D;). His position is neither that universities should become extensions of corporate laboratories nor that academic research should remain isolated from practical needs. Rather, he advocates a complementary partnership in which universities contribute fundamental understanding, specialized expertise, creativity and highly trained researchers, while industry contributes real problems, practical constraints, scale-up capability, operational experience and pathways to implementation.

For Professor Mujumdar, the ultimate objective is not simply to produce more publications. It is to create knowledge and technologies that can, where appropriate, improve industrial practice and generate economic, environmental or societal benefit.

## A philosophy developed through experience

Professor Mujumdar's views on academia-industry interaction have developed through many decades of research and professional service. They are particularly evident in his editorials and presentations concerning industry-academia R&D;, the role of academia in industrial developments, and collaboration in drying research.

His experience has led him to distinguish carefully between academic excellence and practical impact. Scholarly publications and citations are important indicators of scientific communication, but they do not capture every form of engineering impact. A new process may save energy, improve product quality, reduce emissions, lower operating costs or enable a technology to be commercialized without generating a correspondingly large bibliometric footprint.

This broader view of impact is central to his philosophy. He considers engineering research most valuable when fundamental understanding can eventually be connected to a meaningful technological or societal outcome.

## Academia and industry: complementary strengths

Professor Mujumdar emphasizes that universities and industrial organizations have different but complementary missions.

Universities provide an environment for long-term inquiry, fundamental research, education and the development of specialized knowledge. They bring together experts in fields such as transport phenomena, mathematical modeling, computational methods, materials science, process engineering and increasingly artificial intelligence and data-driven methods.

Industry, on the other hand, encounters real problems under real constraints. Industrial organizations understand production requirements, customer expectations, reliability, economics, safety, maintainability, supply chains and market realities. They also possess facilities and operating experience that universities often cannot reproduce.

The most productive collaboration occurs when these capabilities are combined. Industry should not merely receive academic results at the end of a research project. It can help formulate important research questions at the beginning. Academic researchers, in turn, can contribute perspectives and methods that may not exist within the industrial organization.

Professor Mujumdar therefore views collaboration as a process of co-creation rather than one-way technology transfer.

## **The importance of defining the right problem**

One of Professor Mujumdar's strongest messages is that successful R&D; begins with asking the right question.

Academic researchers naturally gravitate toward questions that are scientifically interesting, intellectually challenging and publishable. Industry encounters questions arising from production, energy use, product quality, scale-up, process control, environmental performance and economics.

The intersection of these perspectives can produce unusually valuable research.

This principle is particularly evident in drying technology. Drying involves coupled heat and mass transfer, fluid mechanics, changing material properties, product quality and process control. A laboratory demonstration may establish scientific feasibility, but industrial implementation requires answers to additional questions: Can the process be scaled? Is it reliable? Is the product quality acceptable? Is the energy consumption competitive? Can the equipment be controlled? What is the economic case?

Industrial participation can therefore improve not only technology transfer but the scientific formulation of the original research problem.

## **The laboratory-to-industry gap**

A major concern in Professor Mujumdar's writings is the gap between laboratory research and industrial implementation.

The progression from laboratory to pilot scale, demonstration scale and commercial operation is not simply a matter of increasing equipment size. Scale-up can reveal new flow patterns, heat-transfer limitations, material-handling difficulties, control problems, safety issues and economic constraints.

In drying, these challenges can be particularly pronounced because the material itself changes during processing. Moisture content, temperature, structure, diffusivity and other properties may evolve continuously.

Universities can develop fundamental models and laboratory concepts, but industry often possesses the facilities and operational knowledge required for realistic validation.

Consequently, Professor Mujumdar sees industry participation as especially important when promising research moves toward pilot and full-scale implementation.

## **Benefits to universities and young researchers**

Industry collaboration can enrich academic research in several ways.

First, it exposes students and researchers to genuine engineering problems. Second, it introduces practical constraints that improve the realism of research. Third, it can provide access to industrial materials, data, equipment and operating conditions. Fourth, it gives graduate students experience with multidisciplinary teamwork and professional engineering practice.

Professor Mujumdar places particular importance on mentoring and the development of young researchers. His international research activities have repeatedly emphasized collaboration across disciplines, institutions and geographical boundaries. In his view, researchers should learn not only how to perform technically rigorous research but also how to communicate across disciplinary and organizational cultures.

For international mentees, this is an important lesson: a successful research career is built not only on individual expertise but also on the ability to form productive intellectual partnerships.

## **Benefits to industry**

Industry can gain access to specialized academic expertise that may be difficult or expensive to maintain internally. Universities can offer advanced modeling, experimental techniques, analytical facilities and access to graduate researchers.

An equally important benefit is intellectual diversity. Industrial organizations necessarily focus on existing products, processes and customers. Academic researchers may approach the same problem without the same organizational assumptions and can therefore introduce unconventional concepts.

Professor Mujumdar has long emphasized interdisciplinary thinking. Problems involving drying, energy, sustainability and process optimization often require simultaneous consideration of fluid mechanics, heat and mass transfer, materials science, process control, economics and environmental performance. Collaboration can assemble these capabilities more effectively than either sector working alone.

## **The challenges: different cultures and time horizons**

Professor Mujumdar does not regard academia-industry collaboration as automatically successful. Universities and companies operate under different incentive structures.

An academic researcher may value a publication, a doctoral thesis or a new scientific understanding. An industrial partner may value a patent, a cost reduction, improved reliability or a new commercial product. Their time horizons can also differ. Academic research may appropriately take several years, whereas industry may require a solution within months.

Intellectual property creates another potential source of tension. Universities generally value open communication and publication; companies may need confidentiality to protect competitive advantage.

Professor Mujumdar's approach is pragmatic: these differences should be recognized explicitly and managed through clear agreements concerning objectives, responsibilities, intellectual property, confidentiality, publication and timelines before research begins.

## **Universities should not become inexpensive contract laboratories**

Another theme in Professor Mujumdar's thinking is that universities should not be treated merely as inexpensive sources of R&D; manpower.

The distinctive contribution of academia lies in intellectual capability, fundamental understanding, specialized facilities, creativity and long-term thinking. Conversely, universities should not accept industrial projects simply because they provide funding.

The strongest partnerships are those in which each participant contributes something genuinely complementary. The university should gain intellectually and educationally from the research, while the industrial partner should gain knowledge or technology relevant to an important problem.

This principle protects both academic independence and industrial value.

## **Risk, uncertainty and innovation**

Professor Mujumdar also recognizes an unavoidable tension between industrial risk management and academic exploration.

Industry must manage financial, operational and technological risks. Research, however, necessarily involves uncertainty. If the outcome is completely predictable, the activity is often development rather than research.

The appropriate objective is therefore not to eliminate risk but to manage it intelligently. Fundamental studies, modeling, experiments, pilot testing and staged development can progressively reduce uncertainty before major industrial investment is made.

In this sense, academic research can serve industry not merely by supplying answers but by reducing the uncertainty surrounding potentially valuable technologies.

## **A broader definition of R&D; impact**

For Professor Mujumdar, the impact of engineering R&D; should be assessed more broadly than through publications and citations alone.

Potential outcomes include new scientific knowledge, patents, prototypes, pilot demonstrations, commercial adoption, energy savings, emissions reduction, improved product quality, lower costs, improved reliability, new businesses and social benefits.

He therefore advocates thinking of impact as a continuum:

Knowledge → Concept → Prototype → Demonstration → Scale-up → Adoption → Economic, environmental or societal benefit.

Not every research project will progress through every stage, nor should it. Fundamental research can have enormous long-term value without immediate commercialization. Nevertheless, the full spectrum should be recognized when evaluating engineering research.

## **International and interdisciplinary collaboration**

Professor Mujumdar's philosophy extends naturally to international collaboration. Many modern engineering challenges—energy efficiency, industrial decarbonization, sustainable manufacturing and intelligent process control—are too complex for isolated research groups.

His career has involved extensive international academic interaction and the development of collaborative research networks. The Transport Processes Research Group and the International Drying Symposium are examples of his broader commitment to connecting researchers across institutions and geopolitical boundaries.

He regards intellectual diversity as a source of creativity. Researchers trained in different disciplines and working in different industrial environments may see the same problem differently. Productive collaboration turns these differences into a source of innovation rather than a barrier.

## **Lessons for the next generation of researchers**

For Professor Mujumdar's international mentees, several practical lessons emerge from his experience.

First, learn to identify important problems rather than merely technically interesting ones. Second, develop deep expertise while remaining open to other disciplines. Third, understand the practical environment in which research results may eventually be used. Fourth, communicate clearly with people outside one's specialty. Fifth, establish expectations about intellectual property and publication at the beginning of collaborative projects. Sixth, accept that innovation involves uncertainty and occasional failure.

Most importantly, young researchers should regard collaboration as an intellectual opportunity rather than simply as a funding mechanism. The best collaborations change the way participants think about their problems.

## **Looking toward the future**

The emergence of artificial intelligence, machine learning, digital twins, advanced sensors, electrification, renewable energy and new process-intensification strategies creates a new generation of opportunities for academia-industry collaboration.

Professor Mujumdar's long-standing philosophy is particularly relevant here. Academic researchers can develop models, algorithms and fundamental understanding, while industry provides the operating data, process environments and practical constraints required for validation.

The same principle applies to sustainable industrial drying. Achieving lower energy consumption and net-zero emissions may require combinations of heat pumps, renewable electricity, waste-heat recovery, advanced control, thermal storage and intelligent optimization. No single discipline or organization is likely to possess all the necessary expertise.

The future therefore calls for partnerships that are more integrated, international and interdisciplinary than many traditional university–industry projects.

## Conclusion

Professor Arun S. Mujumdar’s perspective on academia–industry collaboration has emerged from a long career in engineering research, education, mentoring and international cooperation. Its central message is straightforward but consequential: academia and industry should neither be isolated from one another nor expected to become identical institutions.

Academia contributes fundamental knowledge, specialized expertise, creativity, young talent and long-term vision. Industry contributes real problems, practical constraints, scale-up capability, economic discipline and pathways to implementation.

The most productive relationship is consequently one of sustained co-creation. Industrial partners can help formulate meaningful research questions; academic researchers can provide new knowledge and approaches; both can share responsibility for testing, learning and refining solutions.

For Professor Mujumdar, the ultimate measure of engineering research is not publication alone. It is the combination of intellectual excellence with relevance and, where appropriate, the conversion of knowledge into useful technology and broader benefit.

This philosophy is especially pertinent to the next generation of engineers and scientists. As problems become more interdisciplinary and global, the ability to collaborate across academic, industrial, disciplinary and national boundaries will become increasingly important.

His experience suggests a durable principle for young researchers everywhere:

Fundamental understanding provides the foundation; practical problems provide direction; collaboration provides synergy; and implementation transforms knowledge into impact.

## Selected references and sources

- Mujumdar, A. S. — Selected editorials and presentations on industry–academia interaction, industrial developments and drying research.
- Mujumdar, A. S. — University–Industry R&D Collaboration—A Personal Perspective, presentation, 2017.
- Mujumdar, A. S. — Editorials in Drying Technology addressing industry–academia collaboration and the transfer of drying innovations.
- Mujumdar, A. S. — Professional profile and selected presentations available through his professional website.